# Erythrocyte Deformability in a Hyperbolic Microchannel

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**Abstract**

Serious diseases such as diabetes and malaria are deeply related to microcirculation disorders caused by abnormal erythrocytes deformability [1]. Therefore, various studies on red blood cells (RBCs) deformation have been carried out but those studies rather focus on shear flow or extensional flow [2-6]. In this study, a relatively low aspect ratio ($AR$) hyperbolic microchannel was used in order to create an extensional flow combined with a shear flow, where $AR$=$\frac{h}{w}$, h means the depth and w means the width of the microchannel. The objective of the study is to investigate the degree of RBC deformation throughout the microchannel at the centerline ($y = 0$). The blood samples were RBCs diluted with the Hank's Balanced Salt Solution (HBSS) with the hematocrit (Hct) level set to be 2%. A polydimethylsiloxane (PDMS) microchannel, having a hyperbolic contraction region followed by an abrupt expansion shape, was fabricated by a soft-lithography technique. The dimensions of the microchannel: width of the inlet ($w$), length of contraction region (l), width of the exit of contraction ($wc$) and depth ($h$) were 400$\mu m$, 580$\mu m$, 20$\mu m$ and

$14\mu m$, respectively. Hence, the $AR$ was 0.035. The experimental equipment consisted of an inverted microscope (Diaphot 300, Nikon), a high-speed camera (FASTCAM SA3, Photron) connected to a computer and a $1mL$ syringe (TERUMO ® SYRING) controlled by a syringe pump (PHD ULTRA). The manufactured PDMS microchannel was placed on the stage of the microscope where the flow rate $Q$ of the working fluids was kept constant at $0.5\mu L/min$. The flowing RBCs were recorded by a high speed camera at a frame rate of 7500 frames/s and analyzed. The $DI$ was obtained by $DI=\frac{a-b}{a+b}$ where a refers to the major axis and b refers to the minor axis of the ellipse best fitted to RBCs. High $DI$ values in the contraction region were observed. It is possible to say that the RBCs highly elongate with both extensional and shear dominated flows achieved by a hyperbolic microchannel with a relatively low aspect ratio $AR$.

**Keywords: Erythrocytes, Red blood cell, Deformability, Deformation index, Extensional flow, Shear flow, Hyperbolic microchannel.**

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